by the addition of claims 21 and 22. Applicants have amended the specification to correct some inconsistencies and to properly refer to trademarks.

Objections to the Specification

The Examiner objected to the specification. In particular, the Examiner noted that serial numbers should be updated with patent numbers. That is not possible at this time, but several can be updated in the near future. At page 29, the Examiner noted the absence of a serial number for a copending application for which the serial number was not know when the application was submitted. This serial number has been added.

Also, the Examiner noted that two reference numbers in the figures were missing from the application. The Examiner correctly noted that reference number 131 in Fig. 2 corresponded to reference number 132 in the text. Applicants have corrected the figure. Also, Applicants have deleted reference number 317 from Fig. 4. Applicants respectfully request the substitution of corrected Figs. 2 and 4 for the figures as submitted. Appropriate substitute drawings marked in red are enclosed.

Applicants thank the Examiner for the careful reading of the application. In view of these changed Applicants respectfully request the withdrawal of the objection to the specification.

Objection to the Claims

The Examiner objected to claims 1, 10 and 19 for grammatical errors. Applicants have corrected claim 10, as suggested and have corrected claims 1 and 19 with respect to "particles." Applicants request the withdrawal of the objections to the claims.

Rejection of the Claims Under 35 U.S.C. §112, Second Paragraph

The Examiner rejected claims 1-16 under 35 U.S.C. §112, second paragraph as being indefinite. First, the Examiner indicated that the phrase "effectively no" was unclear with respect to scope. While Applicants believe that the language was clear

from the description in the specification, Applicants have replaced this language.

Also, the Examiner indicated that claim 15 did not use standard Markush terminology. Applicants do not agree that their usage was not standard or that standard Markush terminology is required. However, Applicants have replaced the language noted by the Examiner.

In view of the Amendments, Applicants respectfully request the withdrawal of the rejection of claims 1-16 under 35 U.S.C. §112, second paragraph.

Rejection of Claims 1-8 and 19-20 Under 35 U.S.C. §103(a)

The Examiner rejected claims 1-8 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over any one of U.S. Patent 4,861,572 to Sugoh et al. (the Sugoh patent), U.S. Patent 3,406,228 to Hardy et al. (the Hardy patent), U.S. Patent 4,705,762 to Ota et al. (the Ota patent), U.S. Patent 5,635,154 to Arai et al. (the Arai patent), U.S. Patent 5,417,956 to Moser (the Moser patent) and U.S. Patent 5,447,708 to Helble et al. (the Helble '708 patent). The Examiner cited these six references for teaching particle sizes within the claimed range. Applicants believe that each of these references have significant deficiencies with respect to teaching or suggesting Applicants' claimed invention.

With respect to the Sugoh patent, Applicants note that the Sugoh patent does not describe the production of submicron sized alumina. Figs. 3-5 of the Sugoh patent relate to the formation of silica, SiO_2. The corresponding alumina particles were considerably larger. In particular, according to Table 1 of the Sugoh patent, the Al_2O_3 particles had an average diameter of 1.2 microns. Thus, the Sugoh patent does not teach or suggest aluminum oxides within the claimed particle size range.

With respect to the Hardy patent, several deficiencies are apparent. At column 2, lines 6-11, the Hardy patent describes very ambitious small average particle sizes. Unfortunately, these

values do not match the values described in the remaining detailed description of their invention. In column 3, lines 3-37, there is an extensive discussion of the production of particles in the range of 20-200 **microns**. In example 1, the production of nickel oxide particles with average diameters in the range of 20-40 **microns** is described, column 4, lines 43-49. The particle sizes are not described in Examples 2-4. Example 5 describes the production of mixed metal iron oxides by ball grinding. At column 8, lines 24-29, the Hardy patent indicates that "most of the product was in the submicron range." It is not clear what the average particle sizes are in this example, it is clear that there is a wide particle range, since many particles remain larger than a micron. Similarly, example 6 described the production of nickel zinc ferrite with a particle size range from 0.01 microns to larger than a micron, column 8, lines 64-67. Example 7 describes the formation of "submicron iron oxide without any description of the average particle size. Particle sizes are not provided at all for the titanium oxide or zirconium-vanadium blue in Examples 8-10. The **only** mention of aluminum in the Hardy patent is in a laundry list of metals at column 3, lines 38-43 and column 7, lines 50-56. No guidance is provided on how to produce submicron aluminum oxides. They were unsuccessful in producing submicron nickel oxide.

There is no reasonable expectation that aluminum oxide could be produced at all from the disclosure of the Hardy patent. If aluminum oxide could be produced, their is no reason to expect it to be submicron. If submicron, none of the particles produced by the approach described by the Hardy patent has a small particle size distribution as claimed by Applicants.

With respect to the Ota patent, the Ota patent involves the use of flame synthesis. Flame synthesis approaches inherently lead to a broad particle size distribution. In particular, in Table 1 the particle size range for aluminum oxides Al_2O_3 is described as ranging from 10-100 nanometers. This is a very broad range. In

contrast, the particle size distributions shown in Applicants' Figs. 8 and 11 and claimed by Applicants are much narrower. The general particle size ranges are described in Applicants' specification at page 20, lines 16-28 and claims 6-8. The particle size distribution obtained by Applicants is not only narrow, but also has no tail. This feature is described in the specification from page 20, line 29 to page 21, line 10. This lack of a tail is also a feature of claim 1. Since the Ota patent does not teach or suggest appropriately narrow particle size distributions or approaches that could be used to obtain such a narrow particle size distribution, the Ota patent does not render claim 1 obvious.

With respect to the Arai patent, the Arai patent describes generally the production of metal oxides. Also, the Arai patent describes the use of aluminum for the production of metal oxides. However, the examples described in the Arai patent only disclose the production of AlOOH, aluminum oxyhydroxide. Thus, the approach described by the Arai patent does not result in the production of aluminum oxide. Since the Arai patent does not provide any guidance for the production of aluminum oxide in contrast with aluminum oxyhydroxide, the Arai patent does not render Applicants' claimed invention obvious.

The Moser patent describes the production of nanoscale alumina at column 5, lines 23-27, but in the examples the attempt to form alumina particles was unsuccessful. When attempting to make alumina, they obtained some amorphous agglomeration. No sizes were thus given. They speculate that the product was alumina, i.e., aluminum oxide, but they had no data to confirm this conclusion. Thus, the Moser patent does not teach or suggest the production of nanoscale aluminum oxide, let alone nanoscale aluminum oxide with a narrow particle size distribution. Thus, the Moser patent does not render Applicants' claimed invention obvious.

The Helble '708 patent describes an alternative flame synthesis approach. Again, the resulting particle size

distribution is considerably broader than obtained with the approach described by Applicants. Fig. 4 of the Helble '708 patent presents a particle size distribution. The distribution has a considerable tail at both larger and smaller particle sizes. Please note that the graph uses a log scale. The average particle size is 40 nm, column 9, lines 10-11. There are significant numbers of particles with 4 times this particle size, i.e., 160 nm. Thus, the Helble '708 patent does not teach or suggest the production of particles having a particle size distribution as claimed by Applicants.

Because of the deficiencies of each of these references with respect to Applicants' claimed invention, these references do not render Applicants' claimed invention obvious. Applicants respectfully request the withdrawal of the rejection of claims 1-8 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over any one of the Sugoh patent, the Hardy patent, the Ota patent, the Arai patent, the Moser patent and the Helble '708 patent.

Rejection of Claims 1-16 and 19-20 Under 35 U.S.C. §103(a)

The Examiner rejected claims 1-16 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over either U.S. Patent 5,804,513 to Sakatani et al. (the Sakatani patent) alone or in view of U.S. Patent 5,697,992 to Ueda et al. (the Ueda patent), the Ueda patent alone, U.S. Patent 5,868,604 to Atsugi et al. (the Atsugi patent) alone or in view of the Ueda patent, U.S. Patent 4,021,263 to Rosenblum alone or in view of the Ueda patent, U.S. Patent 5,228,886 to Zipperian (the Zipperian patent) alone or in view of the Ueda patent, U.S. Patent 5,300,130 to Rostoker (the Rostoker '130 patent) alone or in view of the Ueda patent, U.S. Patent 5,389,194 to Rostoker et al. (the Rostoker '194 patent) alone or in view of the Ueda patent, U.S. Patent 5,693,239 to Wang et al. (the Wang patent) alone or in view of Ueda, or U.S. Patent 5,527,423 to Neville et al. (the Neville patent) alone or in view of the Ueda patent. The Examiner points to various citations in these patent

referring to aluminum oxide particles having a nanometer size. Applicants note that claims 1 and 19 have an additional limitation related to the particle size distribution. In view of this additional limitation, Applicants believe that all of these references contain significant shortcomings.

Only two of the references discuss the particle size distribution in a significant fashion, the Rostoker '194 patent and the Neville patent. These two references are discussed last. The Sakatani and Ueda patents describe the use of either a flame synthesis approach or a solution based approach (column 4, line 57 to column 5, line 45 in the Sakatani patent and column 4, lines 4-19 in the Ueda patent). These approaches will not produce a narrow particle size distribution as claimed by Applicants. This point is discussed further above and below. The Atsugi patent describes the use of commercially available alumina from Baikowski Japan Co., see column 3, lines 62-65. As discussed further below, alumina with the claimed narrow size distribution is not commercially available. Similarly, the Rosenblum and the Wang patents imply the use of commercial alumina. Also, the Wang patent just describes submicron alpha alumina. The Wang patent does not teach or suggest alumina with an average particle size less than 500 nm and a narrow particle size distribution.

The Zipperian patent describes a list of various polishing agents, which includes Al_2O_3. It is stated that a preferred average particle size ranges from 0.5 microns to 5.0 microns. The Zipperian patent does not exemplify the use of submicron alumina, or at least, does not describe the size of the alumina used in the examples. Similarly, the Zipperian patent does not describe a source or method of producing submicron alumina. Thus, at most, the Zipperian patent suggests the use of commercial alumina.

The Rostoker '130 patent describes the use of alumina with a particle size averaging 40 to 100 nm. The patent indicates that the alumina is produced by a sol-gel process, column 2, lines 30-

35. No details are given of the sol-gel process. Sol-gel processes form a film that must be ground to produce particles. Grinding is notorious for producing a wide distribution of particle sizes. Thus, the Rostoker '130 patent does not teach or suggest an approach to produce Applicants' claimed invention.

The Neville patent not only describes polishing with alumina particles with an average diameter less than 500 nm, but the patent also describes the production approach and particle size distribution. The Neville patent discloses a flame synthesis approach without disclosing significant details of the process, column 6, lines 6-34. The particle size distribution for flame synthesized particles is presented in Fig. 2 of Neville. The Neville patent does not give the details of their flame synthesis approach even though their particle size distribution is significantly narrower than traditional flame synthesis distributions, for example, see figure 4 of the Helble '708 patent discussed above. However, even the narrow particle size distribution shown in Fig. 2 of the Neville patent is considerably broader than the distribution disclosed and claimed by Applicants.

With respect to Applicants' claim 1, the distribution in Fig. 2 of the Neville patent has a significant tail. At the tail, the distribution is dropping off about a factor of five for every 50 nm along the Y axis. Thus, the distribution would not fall off to having less than 1 per million particles until about 500 nm, more than a factor of five greater than the average diameter. Nevertheless, Applicants have amended claim 1 to indicate that the particle size distribution has a value of less than 1 per million particles by a diameter that is a factor of three relative to average diameter. As presently amended, Applicants' claim 1 accounts for any possible moderation of the tail in the Neville distribution at larger particle diameters. However, any error in the tail of the distribution shown in the Neville patent almost certainly would correspond to a corrected distribution with an

extended tail more similar to the tail shown in the Helble '708 patent.

Thus, the Neville patent falls far short of Applicants' claimed distribution. With respect to claim 19, the Neville patent is significantly broadened at both small particle sizes and at larger particles sizes relative to Applicants' claimed distribution. In conclusion, the Neville patent does not teach or suggest Applicants' claimed invention.

With respect to the Rostoker '194 patent, the Rostoker patent does not teach or suggest how to produce the polishing particles with the described narrow particle size distribution. "With respect to the prior art printed publications, these references must be enabling, thus placing the alleged disclosed matter in possession of the public." In re Epstein, 31 USPQ2d 1817, 1823 (Fed. Cir. 1994). "To explain, when the PTO cited a disclosure which expressly anticipated the present invention, ..., the burden shifted to the applicant. He had to rebut the presumption of the operability of [the reference] by a preponderance of the evidence." In re Sasse, 207 USPQ 107, 111 (CCPA 1980).

The Rostoker patent described the use of nanoparticles of Al_2O_3. The Rostoker patent discloses only one approach for obtaining nanoparticles of Al_2O_3, a process described in U.S. Patent 5,128,081 to Siegel et al. (the Siegel patent). However, the Rostoker patent mischaracterizes the properties of the particles obtainable by the process described in the Siegel patent. Significantly, the Siegel patent does not describe the production of nanoparticles with extremely narrow particle size distributions. In fact, the approach described by the Siegel patent using a cold finger that is scrapped is not suitable for the production of particles with an extremely narrow particle size distribution, as claimed by Applicants.

The Rostoker patent describes that a "distribution of particle sizes is controlled to within 'Y' nm." Column 6, lines 8-9. At column 6, lines 14-17, "Y" is described more fully as:

> "Y" is approximately "P" percent of "X", where "P" is 10%, 20%, 30%, 40%, or 50%, and is preferably no greater than 50% to ensure a narrow (Gaussian) distribution of particle sizes about "X"; . . ..

Thus, the Rostoker patent <u>admits</u> that the particle size distribution is a gaussian distribution with a corresponding large <u>tail</u> corresponding to a small but significant number of particles with diameters considerable larger than average. The meaning of "Y" though is still not clear from this description. "Y" is further defined as the inverse of "Q", but the definition of "Q" is no clearer than of "Y".

The precise meaning of "Y" is not significant, though, since the more relevant issue is whether the Rostoker patent enables the practice of Applicants' claimed invention. Applicants believe that it does not. The Siegel patent describes the use of a gas phase condensation approach to producing the particles. This approach leads to a tail at larger particle sizes that brings the distribution outside of Applicants claimed ranges. As evidence of this, Applicants enclose a copy of a reference by Siegel et al., J. de Physique C5: Supplement 10 681-686 (October 1988). The inset in figure 1 shows a particle size distribution for titanium dioxide produced by the gas phase condensation approach. The discussion below figure 1 refers to the distribution as "typical of the particle-size distribution produced in the gas-condensation method."

The long tail at larger particle sizes in the distribution clearly distinguishes the materials from those claimed by Applicants. The average "grain size" is about 13 nm, and a significant fraction of the particles have a size larger than 160 percent of the average, i.e., about 21 nm. The elimination of

larger particle sizes is critical for polishing applications since larger particles can scratch the surface of the material being polished.

With respect to other availability of the aluminum oxide nanoparticles with a narrower size distribution, we note that Dr. Siegel was instrumental in the formation of Nanophase Technologies Corporation (Nanophase). Nanophase was not able to scale up easily the gas-condensation approach described in the Siegel patent. Thus, a variation on the gas-condensation approach was developed, called Physical Vapor Synthesis Approach. While this new approach is suitable for the production of commercial quantities of powders, the particle size distributions for Physical Vapor Synthesis are considerable **broader** than those obtained by the gas condensation approach. Applicants have encloses an advertisement article by Quinton Ford of Nanophase and pages down-loaded from the Nanophase web site that confirm this conclusion. Therefore, the nanoscale particles needed to form the dispersions claimed by Applicants' claim were not commercially available.

With respect to claim 15, the gas condensation approach and the Physical Vapor Synthesis Approach both produce particle size distributions that are gaussian in character. Gaussian distributions inherently have a long extending tail. Part of this tail can be seen in the distribution in the Siegel et al. reference enclosed. Thus, these approaches will result in particles with a diameter that is five times larger than the average particle size. Therefore, the Rostoker patent does not anticipate Applicants' claim 15.

While the Rostoker patent discloses a desire to use abrasive nanoparticles with a narrow size distribution, the Rostoker patent does not teach or suggest how to accomplish this desire. If the required aluminum oxide particles were not available by the approach described in the Siegel patent or commercially available from Nanophase, a person of skill in the art

could not have practiced Applicants' claimed invention based on the disclosure in the Rostoker patent. Thus, the Rostoker patent is not enabling for the practice of Applicants' claimed invention and does not place the public in possession of Applicants' invention.

In conclusion, none of the cited references teach or suggest the narrow particle size distribution of alumina nanoparticles as disclosed and claimed by Applicants. Applicants respectfully request the withdrawal of the rejection of claims 1-16 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over either the Sakatani patent alone or in view of the Ueda patent, the Ueda patent alone, the Atsugi patent alone or in view of the Ueda patent, the Rosenblum patent alone or in view of the Ueda patent, the Zipperian patent alone or in view of the Ueda patent, the Rostoker '130 patent alone or in view of the Ueda patent, the Rostoker '194 patent alone or in view of the Ueda patent, the Wang patent alone or in view of Ueda, or the Neville patent alone or in view of the Ueda patent.

Rejection of Claims 17 and 18

The Examiner rejected claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,064,517 to Shimo (the Shimo patent). The Examiner cites the Shimo patent for disclosing Applicants' claimed invention for the production of nanoscale aluminum oxide particles. Applicants believe that the Shimo patent does not teach or suggest Applicants' process. Applicants respectfully request reconsideration of the rejection of claims 17 and 18 based on the following comments.

The Shimo patent discloses a process involving the initiation of an "exothermic chain reaction." See, for example, column 2, lines 11-17, column 4, lines 1-8, column 6, lines 42-44 and column 14, lines 3-8. The approach described in the Shimo patent is a flame synthesis approach using a laser pulse to initiate the reaction. See, for example, from column 3, line 64 to column 4, line 8, where it is stated that "an exothermic chain

reaction is initiated and propagated throughout the whole volume of the vapor phase to produce a metal oxide in fine particulate form." In contrast, Applicants describe and claim an approach that involves the use of a laser to drive the chemical reaction with heat absorbed from the laser. In Applicants' approach, the laser is necessarily on through the whole synthesis process since the laser is instrumental in inducing the reaction.

Furthermore, the Shimo patent only exemplifies the production of lead oxide, bismuth oxide and two mixed metal oxides. Aluminum was only described in a list of possible metal for use in the Shimo approach. No details are presented for the production of aluminum oxide. Thus, the Shimo patent has several deficiencies with respect to Applicants' claimed invention. The Shimo patent does not teach or suggest Applicants' claimed process. Applicants respectfully request the withdrawal of the rejection of claims 17 and 18 under 35 U.S.C. §103(a).

Rejection of Claims 18 and 19 Over a Combination of References

The Examiner rejected claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over the references cited against claim 1, further in view of the Shimo patent.

The significant deficiencies of the Shimo patent are described above. Some of the references cited against claim 1 above involve flame synthesis similar to Shimo. None of the references teach or suggest laser pyrolysis. Therefore, these references do not make up for the deficiencies of the Shimo reference. Applicants respectfully request the withdrawal of the rejection of claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over the references cited against claim 1, further in view of the Shimo patent.

CONCLUSIONS

In view of the above amendments and remarks, Applicants submit that this application is in condition for allowance, and such action is respectfully requested. The Examiner is invited to

telephone the undersigned attorney to discuss any questions or comments that the Examiner may have.

A fee calculation sheet is enclosed along with a check. Also, the Commissioner is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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